



Editorial

For Future Reference

Will there be a need to expand the reference system in published scientific papers to encompass the wealth of information available on the World Wide Web (WWW)? Some examples in environmental research can be used to examine this concept and compare it with conventional citation policies.

Consider an obscure paper published by this author 11 years ago (1) and compare it to a recent 1996 editorial (2). These papers represent a decade of research, with the first citation appearing as hard copy in various indexes like *Current Contents* or in catalogs like *Index Medicus*. Finding this 1985 journal article and obtaining copies for inspection and verification entails visits to the library or intensive research by library staff, all involving considerable time, multiple people, and sometimes prohibitive cost.

A closer inspection of the 1996 editorial on "Friendly Fire" [*EHP* 104:682 (1996)] reveals a different kind of reference list that cites URLs (universal resource locator) located on the WWW. Placement of the editorial onto the Internet as is the current practice of the journal *Environmental Health Perspectives* (3) enables use of hypertext links to sites that yield further information on related topics. The new process of publication preparation transforms scientific writing, literature review, and citations to a new plane of consciousness for the writer and for the reader. Verification of data, proofing of citations, and examination of hypotheses by comparison with related publications becomes a desktop computer activity that is both complicated by the wealth of information and simplified by the immediacy of the connections.

A journey down a hypertext pathway will serve as a concrete example of scientific investigation. One can pick virtually any word from the title or a general concept to get started. Suppose we use leukemia from the title of the journal article cited above. Use a search engine from one of the internet browsers, software that is free to any user, and then enter the word. The response is immediate and virtually unending, given that the user can remain in the tree of information for days.

Specifically, a search for leukemia yields entirely too much, with the result: "Lycos search: leukemia 66,557,959 unique documents in catalog. Your query resulted in 4,691 relevant documents on 470 pages." Search the number 1 hyperlink among the dozens provided, which is listed as 100% relevant, and the result is "Art's leukemia and bone marrow transplant links" (4).

At first glance, it appears we have received a curve ball and a useless page, but the additional color-highlighted hyperlinks listed on that site include *prostate cancer*, *cancer FAQ*, *CancerNet*, *NIH main page*, *Oncolink*, *leukemia information*, *leukemia links*, *The Medical Information Archives*, *bone marrow transplant information*, *other institutional servers*, *blood transfusions*, *commercial servers*, *journals*, *papers and reports*, *news*, *alternative therapies*, *other people's pages (with cancer)*, *drugs and pharmaceuticals*, each of which contains a brief description of what is present on that site.

Assuming that we are writing a paper and don't succumb to the overwhelming temptation to go off on a tangent exploring, a click on *journals* (URL) yields *JNCI*, *Exp. Hematol.*, *J. of the AMA*, *Science*, *NEJM*, *Cancer Journal*, *The Lancet Online*. Following along, *Science* (5) then yields a journal-specific search engine. If October 1995

"All truths are easy to understand once they are discovered; the point is to discover them."

Galileo

through October 1996 is examined, 14 articles on leukemia data are displayed. Full text of an article by Murphy [*Science* 273:746] titled "The Public Health Risk of Animal Organ and Tissue Transplantation into Humans" contains nine references to articles published in books, journals, newspapers, and meeting reports on the subject.

It is apparent that the optimal operational mode for publishing scientific papers has emerged as an internet-linked integration of searching, reading, users choice of printing, referencing using URLs, and comparison of up-to-date information on topics of choice. How could a non-linked scientist keep up with the competition otherwise? One can purchase software to scan a user-chosen list of journals or any other periodicals for key words or phrases, have the search run overnight, and download information on titles or even entire articles of interest for perusal the next day.

Another example of specific information vital to the publication process should underscore the importance of this service to the scientific endeavor. *Environmental Health Perspectives* received a submission that was reviewed by peers, examined by editors, revised by authors, laid out by desktop publishers, and examined again by editors before galley proofs were sent to authors for verification. Editorial inspection of the galley revealed that the paper was incomprehensible without proper identification of an unknown item called "zanba" that was mixed into brick tea, a staple of the Tibetan diet. The concoction was contaminated by fluoride, and one group of Tibetans used the unknown item and another group did not. Nowhere had the authors identified the meaning of the word. A search of "zanba" on one search engine yielded no returns, but another search engine cited a URL on Chinese Tourist Information (6), which stated that "zanba" was roasted qingke barley flour, an explanation added to the paper that was unavailable in *Webster's*, and weeks away from the Chinese authors by snail-mail. Similar questions and answers can sometimes be solved by FAX or e-mail to authors, if time permits, but authors of international papers often lack sophisticated technological equipment.

As science editor for a "wired" journal, I have the luxury of including URLs as references, but the practice of other journals of substituting URLs for standard reference formats is untested. A letter-to-the-editor in *Science* referred to the topic and predicted this practice would become the norm in the future. Inasmuch as hundreds of science journals are now on the WWW, the use of URLs as references represents advancements in information transfer that will improve the scientific product and at the same time provide stimulants for new avenues of investigation. The future is now.

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• Science Editor

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